TABLE A-1.3
CCIR RAIN MODEL DATA R = 60.00 & 70.00

R(0.01)% =   60.00

		Availability (%)		
Dist (mi)	99.99	99.98	99.95	99.90
2.0	31.8	23.9	16.4	12.4
2.5	38.5	29.0	19.9	15.0
3.0	44.9	33.8	23.2	17.5
3.5	50.9	38.3	26.3	19.8
4.0	56.5	42.5	29.2	22.0
4.5	61.9	46.6	32.0	24.1
5.0	66.9	50.4	34.6	26.0
5.5	71.7	54.0	37.1	27.9
6.0	76.3	57.4	39.4	29.7
6.5	80.7	60.7	41.7	31.4
7.0	84.8	63.8	43.8	33.0
7.5	88.7	66.8	45.9	34.5
8.0	92.5	69.6	47.8	36.0

R(0.01)% =   70.00

		Availability (%)		
Dist (mi)	99.99	99.98	99.95	99.90
2.0	37.3	28.1	19.3	14.5
2.5	45.2	34.0	23.4	17.6
3.0	52.7	39.6	27.2	20.5
3.5	59.7	44.9	30.9	23.2
4.0	66.3	49.9	34.3	25.8
4.5	72.6	54.6	37.5	28.2
5.0	78.5	59.1	40.6	30.6
5.5	84.2	63.4	43.5	32.8
6.0	89.5	67.4	46.3	34.8
6.5	94.6	71.2	48.9	36.8
7.0	99.5	74.9	51.4	38.7
7.5	104.1	78.4	53.8	40.5
8.0	108.5	81.7	56.1	42.2

TABLE A-1.3
CCIR RAIN MODEL DATA R = 80.00 & 90.00

R(0.01)% =   80.00

| | | Availability (%) | | |
Dist (mi)	99.99	99.98	99.95	99.90
2.0	42.9	32.3	22.2	16.7
2.5	51.9	39.1	26.9	20.2
3.0	60.5	45.5	31.3	23.5
3.5	68.6	51.6	35.4	26.7
4.0	76.2	57.3	39.4	29.6
4.5	83.4	62.8	43.1	32.4
5.0	90.2	67.9	46.6	35.1
5.5	96.7	72.8	50.0	37.6
6.0	102.8	77.4	53.2	40.0
6.5	108.7	81.8	56.2	42.3
7.0	114.3	86.0	59.1	44.5
7.5	119.6	90.0	61.8	46.5
8.0	124.6	93.8	64.4	48.5

R(0.01)% =   90.00

| | | Availability (%) | | |
Dist (mi)	99.99	99.98	99.95	99.90
2.0	48.4	36.4	25.0	18.8
2.5	58.7	44.2	30.3	22.8
3.0	68.4	51.4	35.3	26.6
3.5	77.5	58.3	40.0	30.1
4.0	86.1	64.8	44.5	33.5
4.5	94.2	70.9	48.7	36.7
5.0	101.9	76.7	52.7	39.7
5.5	109.2	82.2	56.5	42.5
6.0	116.2	87.5	60.1	45.2
6.5	122.8	92.4	63.5	47.8
7.0	129.1	97.2	66.7	50.2
7.5	135.1	101.7	69.8	52.6
8.0	140.8	106.0	72.8	54.8

R(0.01)% = 100.00

Availability (%)

Dist (mi)	99.99	99.98	99.95	99.90
2.0	54.0	40.7	27.9	21.0
2.5	65.5	49.3	33.8	25.5
3.0	76.3	57.4	39.4	29.7
3.5	86.4	65.0	44.7	33.6
4.0	96.0	72.3	49.6	37.4
4.5	105.1	79.1	54.3	40.9
5.0	113.7	85.6	58.8	44.2
5.5	121.9	91.7	63.0	47.4
6.0	129.6	97.5	67.0	50.4
6.5	137.0	103.1	70.8	53.3
7.0	144.0	108.4	74.4	56.0
7.5	150.7	113.4	77.9	58.6
8.0	157.1	118.2	81.2	61.1

R(0.01)% = 110.00

Availability (%)

Dist (mi)	99.99	99.98	99.95	99.90
2.0	59.6	44.9	30.8	23.2
2.5	72.3	54.4	37.4	28.1
3.0	84.2	63.4	43.5	32.7
3.5	95.4	71.8	49.3	37.1
4.0	106.0	79.8	54.8	41.2
4.5	116.0	87.3	60.0	45.1
5.0	125.5	94.5	64.9	48.8
5.5	134.5	101.2	69.5	52.3
6.0	143.1	107.7	74.0	55.7
6.5	151.2	113.8	78.2	58.8
7.0	159.0	119.6	82.2	61.8
7.5	166.4	125.2	86.0	64.7
8.0	173.4	130.5	89.6	67.5

TABLE A-1.3
CCIR RAIN MODEL DATA R = 120.00

R(0.01)% = 120.00

Availability (%)

Dist (mi)	99.99	99.98	99.95	99.90
2.0	65.3	49.1	33.7	25.4
2.5	79.1	59.5	40.9	30.8
3.0	92.1	69.3	47.6	35.8
3.5	104.4	78.6	54.0	40.6
4.0	116.0	87.3	60.0	45.1
4.5	127.0	95.6	65.6	49.4
5.0	137.4	103.4	71.0	53.4
5.5	147.2	110.8	76.1	57.3
6.0	156.6	117.8	80.9	60.9
6.5	165.5	124.6	85.5	64.4
7.0	174.0	130.9	89.9	67.7
7.5	182.1	137.0	94.1	70.8
8.0	189.8	142.8	98.1	73.8
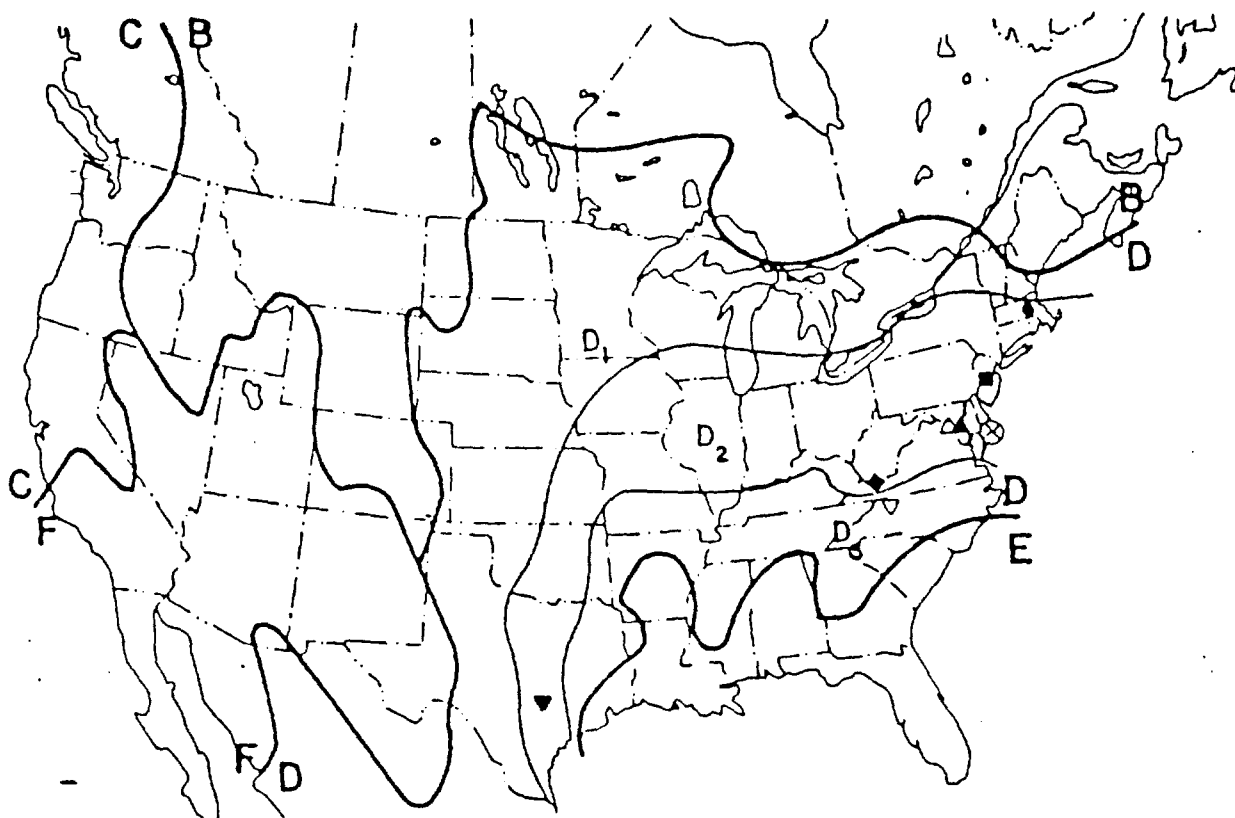
LOCATIONS USED FOR SLANT PATH MEASUREMENTS

- WALTHAM, MASS.
- HOLMDEL, N.J.
- GREENBELT, MD.
- CLARKSBURG, MD.
- BLACKSBURG, VA.
- ROSMAN, N.C.
- WALLOPS ISLAND, VA.
- AUSTIN, TEX.

Figure A-1.1 Rain Rate Climate Regions

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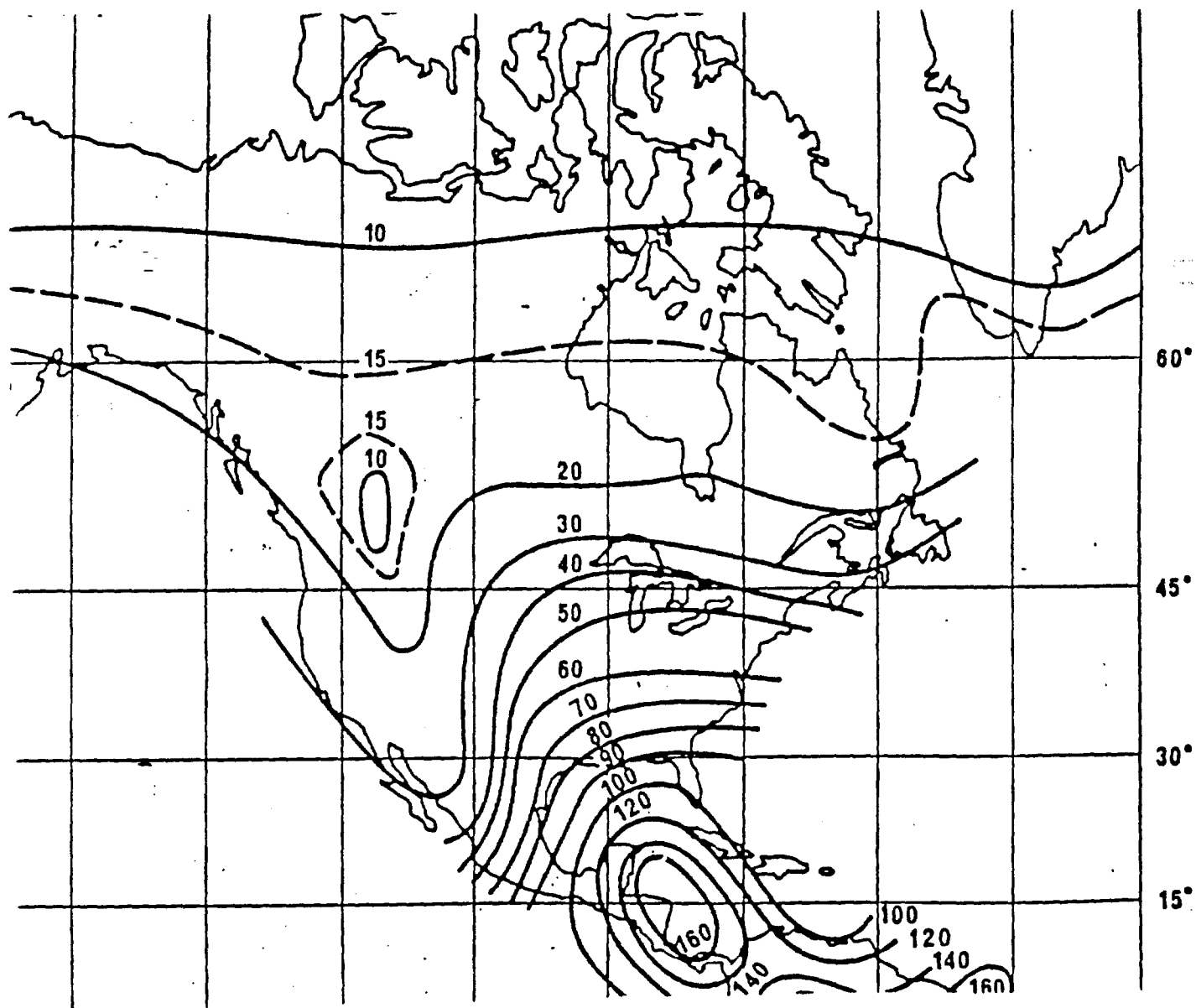
Figure A-1.2 (a) 0.01% Rain Rate Contours

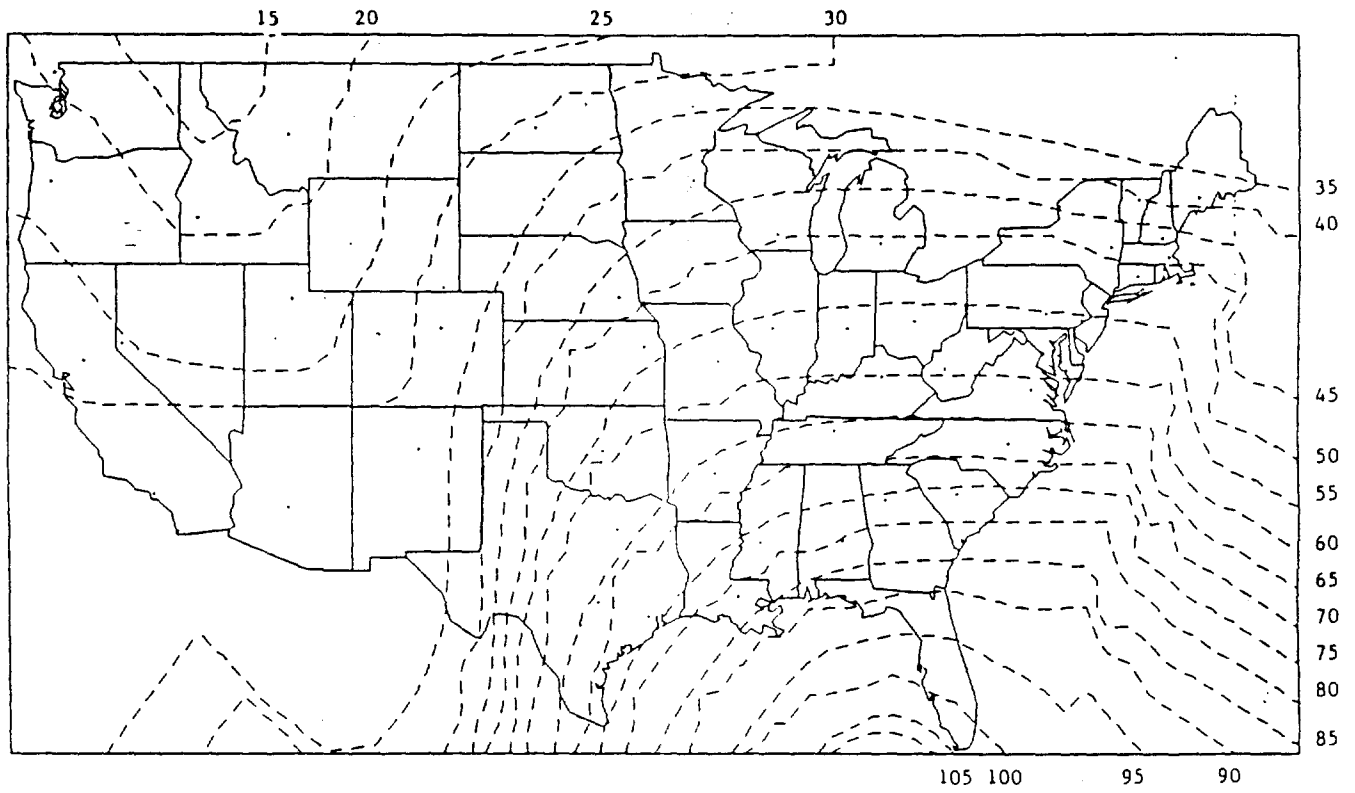CCIR RAIN RATE CONTOURS (MM/HR). 0.01% EXCEEDANCE PROBABILITY

Figure A-1.2 (b) CCIR Rain Rate Contours Probability

A-2. Rain Depolarization

Let A be the copolarized path attenuation due to rain. Then, an estimate of the cross polarization discrimination (XPD) can be made using the following equation (see CCIR Report 722-1 1982):

$$XPD = 30 \log(f) + 9 - 23 \log A$$

where

$$f = 28 \text{ GHz and } A \geq 15 \text{ dB}$$

At New York the value of A, for 99.9% availability, is 6.126 D/(1 + 0.07151D), where D is the path length in miles. If D = 3.5 miles, A equals 17.15 dB. For this distance XPD equals 24 dB. This is sufficiently high to be not a problem.

A-3. Point-to-Point Interference

It is implicit in the above discussion that a subscriber is communicating with another subscriber (in the same or another cell) through the central node, and not directly with any other subscriber. In general, this is not the only way that two subscribers can communicate with each other. Point-to-point links can be established within a cell directly between two subscribers, although this is not the way the Suite 12 system is configured. Even then, it is interesting to explore how many such point-to-point links can exist within a cell so that they do not substantially interfere with each other.

The interference scenario that should be addressed in such a situation is addressed in Fig A-3.1. Consider the interference to a receiver R. The line of sight RA subtends angles ϕ_1 and ϕ_2 to the paths RC and AB. These two angles are critical to the determination of the interference levels. If both the angles are larger than 5° (assuming that the antennas at locations A and R are of, say, 38 dB gain), the receiver R gets an attenuation of 50 dB due to the combined sidelobe rejection of the two antennas. Let d be the distance AR, and let the distance AB be 3 miles. Further let the antennas A, B, and R are of 38 dB gain, the CNR for the wanted signals at R and B be the same, and finally let the noise figures of the receivers R and B be the same. Then it can be shown that carrier-to-interference ratio C/I at location R is 20 log (d/3) + 50 + X, dB, where X equals 0 or 25 dB, depending upon whether links AB and RC are copolarized and or cross polarized. If this ratio should be at least 25 dB (FM and digital), the distance d should be no smaller than 890 ft. for copolarized signals and 50 ft. for cross polarized signals. This implies that for a copolarized 3 mile point-to-point link that use 38 dB gain dishes, there is a "forbidden" region of approximately 890 ft. radius around its transmitting antenna, within which all the video receivers should have look-angles ϕ_1 and ϕ_2 that are at least 5°. (Incidentally, this conclusion is independent

of the frequency of transmission, within millimeter wave frequencies, and solely depends upon the ability of the antenna to provide a sidelobe rejection of 25 dB at an off-set angle of 5°. The gain of 38 dB is also not critical to the argument, except that this gain appears to be the standard for point-to-point links.) Let a volume of dimension 890 ft. x 890 ft. x 70 ft. be declared as the forbidden region around every transmitter of the point-to-point links, within which no receiver of another point-to-point link can be placed. Now let the cell have an area of 3 miles x 3 miles, and a height of up to 70 ft. Then the total number of the forbidden regions in the cell has a theoretical upper limit of 316. Consequently the number of simplex and duplex links in the cell can be theoretically as large as 316 and 158 respectively.

The forbidden zone is only for transmitters and receivers operating at the same frequency. Obviously operation within the forbidden zone is allowed for other frequencies. If 4600 MHz of bandwidth were available for point-to-point radios (the existing 18 GHz, 21 GHz, and 30 GHz bands) and each radio occupies an average 50 MHz band, an improvement factor of 92 times is possible. This allows the coexistence of 29,072 or 14,536 co-polarized FM and digital point-to-point links in the same cell area.
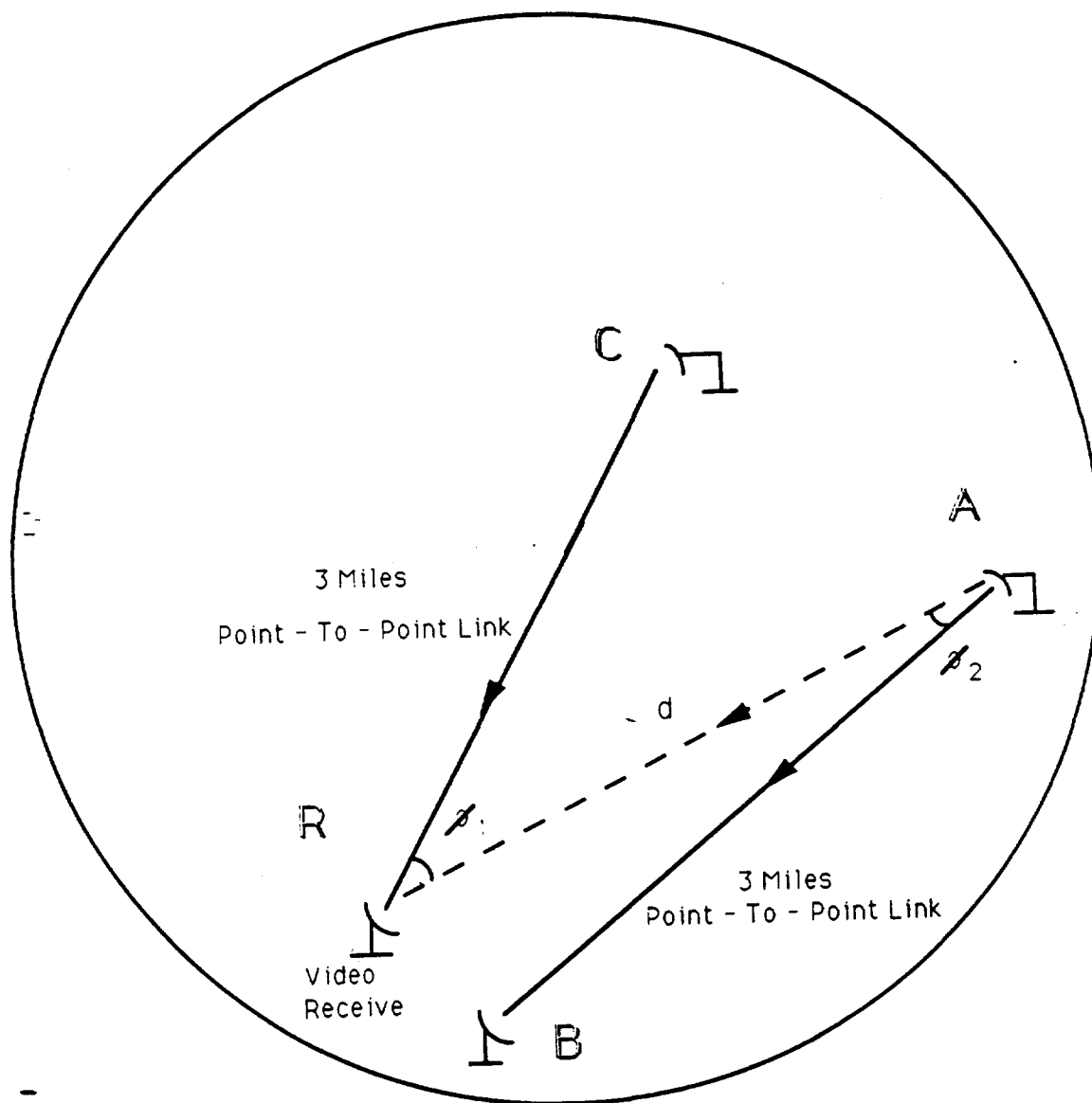
Figure A-3.1 Coexistence of point-to-pint links at the same frequency.